AUTHOR: CHRISTIAN JONGENEEL
PHOTOS: SAM RENTMEESTER

Biofuel seeks endorsement

PhD-student Peter Mooij takes a sample out of a pit. He is looking at possibilities for extracting biodiesel from algae.

Biofuels such as ethanol from sugar cane and cellulose 'waste' are theoretically sustainable, as their combustion releases no more CO_2 than is absorbed during production. Even so, they are also controversial, because they are believed to be grown at the expense of food crops, or because areas of rainforest are believed to the cleared for them. However, as far as sustainable energy forms are concerned, it is all hands on deck to halt climate change, and TU Delft is one of those hands.

Last summer, the Commission on Global Security, Justice and Governance, a think tank chaired by the former U.S. Secretary of State Madeleine Albright, launched its report containing recommendations, one of which was based on the outcomes of research conducted at Delft. The research focused on efficient land use for biofuel crops in developing countries. One of the main stumbling blocks turned out to be a lack of knowledge and access to patented technologies. Delft suggested financing this knowledge and access using the Copenhagen Climate Fund, and the commission agreed it was a good idea.

This is the kind of research that Prof. Patricia Osseweijer of Science Communication and group leader in Biotechnology and Society is proud of, as it connects technical knowledge with social issues. 'The task of a university goes beyond acquiring knowledge,' she says. 'It is also about transferring that knowledge to those places where it is needed. In fact, I believe scientists are ideally positioned to make that connection.'

On 1 September, Osseweijer was appointed Distinguished Lorentz Fellow for one year at the KNAW institute NIAS. This award encourages research at the interface between the humanities, social sciences and natural and technological sciences. She intends to use this year to increase the sense of urgency surrounding bio-based production. 'The EU has set climate targets for the year 2030, but the year is getting closer faster than the targets are.'

Sugar cane

Much of the controversy surrounding biofuels is unnecessary, says Osseweijer: 'Calculations show that the sustainable production of biomass is theoretically possible, and therefore not at the expense of nature and food production. The two main obstacles are political instability and war, and the fossil fuel-based financial system is also a problem.'

Osseweijer is aware that these are no minor problems. Biofuels have a long way to go, but there are already some good examples. One of these is Brazil, which has put the infrastructure in place over the last 40 years to produce ethanol from sugar cane, which is blended for up to one quarter of the volume with petrol. 'The sugar cane is grown on just 4% of the total area of agricultural land, well away from the Amazon area. What is more, the ethanol is cheaper than petrol.'

Although its potential is far from being fully realised, there is increasing success with the production of fuel from cellulose – long fibres that are difficult to break down. Worldwide, there are currently five factories that convert cellulose to ethanol. One of these is owned by the Dutch company DSM, based in Emmetsburg, Iowa, where maize production creates a lot of residual waste. The special yeast capable of decomposing both C5 and C6 sugars was developed at TU Delft.

'People won't take you at your word it if you say something is a positive development. You need to discover and recognise the values on which they base their opinions'

The factory is one example of fundamental TU Delft microorganism research reaching a large-scale production stage. The university was also regularly involved in the intermediary stages, such as the Bioprocess Pilot Facility in Delft, in which the university spin-off Delft Advanced Biorenewables (DAB) looks at how best to scale-up the conversion and separation of oil from biomass. 'This too is a great example of how you can integrate knowledge of fundamental biotechnology, processes and market forces,' says Prof. Luuk van der Wielen of Biobased Economy.

Van der Wielen realised ten years ago, when the first fundamental research into fuel from biomass began to bear fruit, that scaling-up to production levels would present a major challenge. 'By definition, biomass contains a lot of water, while you want to use it in existing fuel systems and combustion engines that do not tolerate water,' he explains. 'You would think that the oil will simply float on the water, but in practice you often get a kind of mayonaise from which you need to extract the oil.'

To compete with petroleum, such processes need to be operationalised without the funding used to develop them. Van der Wielen therefore also develops scenarios: is it possible to make a certain process cost-effective in the Netherlands and, if not, what can be done differently? For example, a recently published book, *Redefinery*, showed – based on a large number of studies – that it is possible to use biokerosene in Dutch aviation. All that is required is enough sustainably produced biomass.

'Our scenarios for the aviation sector are supported by the sector,' says Van der Wielen. 'They have been included in the Energy Agreement and are embraced by the Dutch government. They are set to become part of government policy.'

Oily algae

While van der Wielen focuses on the commercialisation of processes, fundamental research into new fuels continues. PhD candidate Peter Mooij, for example, is looking at possibilities for extracting biodiesel from algae.

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Algae can grow in seawater, and therefore do not require valuable agricultural land or fresh water.
'Just like people, algae store energy in two different ways: as starch or as fat,' explains Mooij. 'We are looking for a recipe that ensures that nature selects the best algae. For example, regular exposure to cold nights can encourage algae to store energy. We now have a stable method, but the algae mainly store this energy in the form of starch.'
Mooij is continuing his search for algae that mainly store fat. One option could be to select the algae by weight, as oil is lighter than starch: scoop the top layer out of the barrel and use that for the next batch. As well as this practical approach, Mooij is focusing on why algae produce fat in the first place. This question is more difficult to answer but will result in knowledge that helps point algae in the direction of oil factories.

Support

Obviously there is no shortage of technological opportunities – from plausible scenarios to oily algae. 'Ultimately, however, we will need to rally more public support for biofuels,' says Osseweijer. 'People won't take you at your word it if you say something is a positive development. You need to discover and recognise the values on which they base their opinions, and then demonstrate that a technology can contribute to these values. I would like to analyse how this works for bio-based products, and I am actually organising a workshop in January with experts from various fields.'

'The two main obstacles are political instability and war. The fossil fuel-based financial system is also a problem'

She is particularly interested in looking beyond the Netherlands. TU Delft is also working with foreign partners, such as several Brazilian universities and companies, to continue to explore the possibilities of biomass (not just for biofuels). An agreement was recently signed that will result in 100 extra PhD positions in the coming years – a considerable, but highly necessary, expansion in research capacity. Osseweijer refers to a recently published report by the Scientific Committee of Problems on the Environment (SCOPE) that identified research needs: 'Current global biomass consumption represents about 10% of the total global energy consumption. Of this, about two thirds is used in poor areas, mainly as firewood for cooking. This is highly inefficient and unhealthy and, although there are good alternatives, insufficient use is made of them. Although it is theoretically possible to achieve both a higher food production and a sustainable energy supply on existing agricultural land, there are still many gaps in our knowledge to be filled before we can reach that point.'

The Bioprocess Pilot Facility in Delft, in which the university spin-off Delft Advanced Biorenewables (DAB) looks at how best to scale-up the conversion and separation of oil from biomass.

Speed of sea level rise may be **twice as fast** or more

Sea levels may rise a lot more this century than is assumed in the IPCC report. This is the conclusion drawn by Dr Riccardo Riva and his colleagues in a recent article in Climate Research.

Riccardo Riva, lecturer in the Department of Geoscience and Remote Sensing (Faculty of Civil Engineering and Geosciences) and the TU Delft Climate Institute, published an article in Climate Research last summer together with colleagues from Copenhagen, Liverpool and Beijing on sea level rise predictions in the 21st century for northern Europe.
There is no doubt that sea levels will rise, due to the accelerated melting of glaciers, the loss of land-based ice masses on Greenland and the South Pole that run into the sea, and expansion of the world's oceans as they warm. These various contributions together tell us what the global average sea level rise will be. The water will not rise uniformly across the globe. Local effects such as the uplift of continents that were covered with ice during the Ice Age may cause an annual sea level drop of one metre. The melting of the ice sheets also reduces the local gravitational pull, which means that melting ice on Greenland may cause a local fall in sea level as far away as Norway or Ireland. Such factors can impact local sea levels.
The researchers took the business-as-usual scenario of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) as their reference point. This scenario assumes only a slight decrease in CO_2 emissions, and continued economic growth, resulting in an average temperature by the end of the century that is five degrees higher than pre-industrial levels.

There is no doubt that sea levels will rise, but the water will not rise uniformly across the globe

For cities near the North Sea (from London to Hamburg), this means a sea level rise of 80 centimetres by the end of the century.
However, the researchers claim that an additional rise of 95 centimetres is also possible, due to melting ice on the South Pole. Riva and his colleagues point to other studies showing that the rate of melting of glaciers on Antarctica is accelerating, which is associated with a local knock-on effect. Therefore, 80 centimetres is the most likely scenario, but there is a significant risk of water levels rising more than twice as fast. Water levels will also continue to rise, and more rapidly, after 2100.
The researchers therefore recommend this to be taken into account in climate change policies. JW

Waslak Grinsted, Svetlana Jevrejeva, Riccardo Riva, Dorthe Dahl-Jensen, Sea level rise projections for northern Europe under RCP8.5, Climate Research, 17 June 2015